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Use of Inedible Fats in Dry Dog Foods and Poultry Rations

(Report of work carried out under contract with the United States Department of Agriculture)

By

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FOREWORD

For many years beef normally has been sold at wholesale for less than the cost of the live animal. This was possible because the packer was able to cover the costs of processing and marketing and even establish a modest profit through efficient utilization of the by-products, such as hide, hair, bones, fat and glands.

In recent years the margin between the cost of the live animal and the value of the by-products has been decreasing sharply. The price of tallow is a typical illustration. From 1910 to 1920 the average price per pound of tallow was very close to that of the live animal. From 1920 to 1947 the price fluctuated from 50 to 90 per cent of that of the live animal. At present, however, the price per pound of tallow is only about 20 per cent of the average cost of the live animal.

The consumer and the livestock producer, as well as the packer, benefit when maximum value is obtained in the utilization of these by-products. Thus, from the viewpoint of all concerned, the depressed relative values of by-products of meat processing point sharply to the need for more research to develop new and more valuable uses for such products.

The results of studies conducted by the Division of Biochemistry and Nutrition and the Division of Organic Chemistry of the American Meat Institute Foundation on the use of inedible animal fats in dry dog meals and poultry rations are particularly timely. These studies are reported here and include nutritional studies with Cocker Spaniel pups, New Hampshire and White Rock chicks, and on the value of antioxidants in stabilizing the fats and vitamin A in mixed feeds.

This is a report of work done under contract with the U. S. Department of Agriculture and authorized by the Research and Marketing Act of 1946. The contract is being supervised by R. W. Riemenschneider of the Eastern Regional Research Laboratory of the Bureau of Agricultural and Industrial Chemistry.

H. R. Kraybill, Director
Research and Education

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INTRODUCTION

Approximately one million tons of inedible animal fats are produced annually in the United States. Traditionally, this abundant supply of tallows and greases has constituted a principal source of fats utilized in the manufacture of soap and for a number of other industrial uses. With the technological developments in recent years, however, competitive materials from other sources have been introduced, and these materials have found substantial favor for many uses previously reserved to by-product fats resulting from meat processing operations.

The economic imbalance between costs of production and market values resulting from this contraction of effective utilization of animal fats has been apparent for some time. As a consequence, interest in potential new uses for these products has been increasing steadily, and considerable scientific attention has been directed to the problem.

In this connection, it is important to remember that the value of by-product fats is of importance to the entire national economy. Until recently, the economic return from the many items produced as by-products of the processing of livestock actually has defrayed packing plant operating costs and has provided the profits earned by the meat processing industry. In most normal operating years, industry economists have shown that effective by-product utilization has permitted meat to be offered on the wholesale market at prices equal to or less than the proportionate live animal cost.

Inedible tallows and greases represent one of the most important of the by-product items. Their production almost universally is an integral part of the operations of establishments engaged in the dressing of livestock. The price paid for fats and oils is reflected not only in the operating results of meat processing and specialized fats and oils industries but also in the relationship between the market value of livestock sold for slaughter and the cost of meat to the consumer.

GENERAL SIGNIFICANCE

One possible use of inedible fats is in dry dog foods and poultry rations. Conservative estimates show that 340,000 tons of dry dog meals are produced (1947) in the United States each year. Commercial dog meals contain approximately 5 per cent of fat – as contrasted with a much higher level of dietary fat included in canned dog foods. This variation in fat content has been regarded as of possible nutritional and economic significance and worthy of close scientific scrutiny.

The annual consumption of feeds by poultry has been estimated at about 30 million tons. The consistent trend in poultry raising circles in recent years has been toward use of high energy rations for chicks raised as broilers, and mixed feeds of this type generally have produced the best growth results. In this connection, preliminary studies indicated that inedible fats might be used successfully to increase the calories contributed by each pound of the ration.

To our knowledge, a study of the effects of adding graded levels of fats to practical type rations for dogs and chicks has not been reported. Entirely aside from the nutritional benefits that might accrue from successful experimentation in increasing the dietary fat content of dry dog meal and of mixed poultry feeds, research in this field appeared to be warranted by the potentialities for effective utilization of by-product animal fats. If, for example, research results justified an increase of 4 per cent in the fat content of dog food and broiler feeds, some 140,000 tons of animal fats would be required to meet the need. This, of course, would be equivalent to approximately 14 per cent of the total production of such by-product animal fats. Actually, as the data included in this Bulletin discloses, the results of our studies indicate that more than 4 per cent of added fat may be used advantageously.

In order to critically ascertain the value of adding animal fats to dog or poultry rations, it was necessary to develop basic information of two main types:

(a) To determine the nutritional performance of dogs and chicks fed diets containing graded levels of inedible animal fats, and

(b) To establish an effective method of stabilizing the fat against development of rancidity by addition of suitable antioxidants.

The studies in these connections have been conducted and clearly indicate the practicality of adding by-product animal fats to animal feeds. The research results on which our conclusions have been based are pre-

sented in succeeding paragraphs of this Bulletin.

NUTRITIONAL EXPERIMENTS WITH DOGS

Registered young Cocker Spaniel pups were fed a basic diet composed of ingredients commonly used in commercial dog meals. Control groups of dogs were fed the basic diet without added fat. Other groups of dogs were fed the basic diet plus 4 per cent, 6 per cent, or 8 per cent of intermixed choice white grease. The grease previously had been stabilized by the addition of certain antioxidant compounds (see section on stability studies). Ingredients used and the proximate composition of the basal ration are shown in Table 1. The rate of growth, food and caloric utilization and general performance of these dogs were determined over a 10-week period.

TABLE 1

Composition and Proximate Composition of Basal Rations for Dogs

Ingredient	%
Corn flakes	26.75
Wheat flakes	26.70
Soybean grits	19.00
Meat and bone scrap	15.00
Fish meal (menhaden)	3.00
Wheat germ meal (defatted)	5.00
Dried skim milk	2.50
Fish liver oil (2500 units A, 400 D/g)	0.50
Iodized salt	0.25
Brewer's yeast (non-debittered)	0.50
Riboflavin supplement (BY-500)	0.80

Proximate Analysis

Protein	29.1
Ether Extract (fat)	3.7
Ash	6.7
Fiber	2.4
Moisture	6.3

Two experiments were conducted. In the first experiment male and female dogs were used. In the second experiment female pups were used,

and studies with these dogs are being continued to determine the effect of adding fat to the ration on the reproduction and lactation performance.

In addition to these tests, comparative studies were conducted with a commercial meal (5.9% fat). The pertinent results for these experiments are summarized in Table 2.

TABLE 2

Performance of Dogs Fed Graded Levels of Choice White Grease

Supplements to Basal Diet	Av. Gain in Wt. Grams/wk.	Food Efficiency[1]	Caloric Efficiency[2]
Experiment 1			
Commercial ration	334	0.22	6.2
Commercial ration plus 6% fat	383	0.24	6.2
Basal ration	371	0.22	6.1
Basal ration plus 6% fat	439	0.25	6.5
Experiment 2			
Basal ration	339	0.18	5.2
Basal ration plus 4% fat	360	0.17	4.5
Basal ration plus 8% fat	334	0.17	4.4

[1]Grams gain per gram food consumed.
[2]Grams gain per 100 crude calories consumed.

It can be seen from these data that the growth rate of the dogs fed added fat was equal to, or slightly better than, that for the dogs fed the basal ration. The food and caloric efficiencies for the dogs fed added fat were improved slightly in the first experiment and were reduced slightly in the second experiment when additional fat was fed. Although additional work is needed on the reproduction and lactation performance of the dogs, it is clear that the performance of the young growing pups fed the added fat was equal to, or slightly superior to that for the dogs fed the basal diet without added fat.

NUTRITIONAL EXPERIMENTS WITH CHICKS

Corollary studies were conducted with New Hampshire and White Rock chicks (mixed sexes) that were fed diets, with and without additions of inedible animal fats, up to market size as broilers (9 weeks of age). These tests were conducted with a basal ration of commonly used ingredients to which either no fat, 2%, 4%, or 8% stabilized fat was added. Other

groups were fed these graded levels of fat in addition to the basal rations and other supplements (choline and an antibiotic plus vitamin B_{12} supplement). The basal diet in this test and its proximate composition are shown in Table 3.

TABLE 3

Ingredients and Proximate Composition of Basal Diet for Chicks

Ingredient	%
Yellow corn, ground	65.2
Soybean grits	11.0
Meat scrap	8.0
Fish meal (menhaden)	8.0
Blood meal	2.0
Corn gluten meal	2.0
Alfalfa leaf meal (dehydrated)	2.0
Riboflavin supplement (BY-500)	1.0
Fish liver oil (2250 units A, 400 D/g)	0.3
Iodized salt	0.5
	mg/Kg
$MnCl_2 . 4 H_2O$	320
Niacin	20

Proximate Composition*	%
Protein (N x 6.25)	23.7 (22.9)
Ether Extract (fat)	3.4 (3.9)
Moisture	10.9 (10.8)
Ash	6.3 (6.2)
Fiber	2.5 (2.8)

* Since the soybean grits used in the first experiment were not available for the second experiment, a meal of lower protein content was used. The proximate composition of the ration used in the second experiment is shown in parentheses.

The results for the two experiments (the first with New Hampshire chicks and the second with White Rock chicks) are summarized in Table 4. Twenty-five chicks were used in each group and the results observed at the end of the experiment (9 weeks) are shown.

TABLE 4

Gain and Feed Utilization of Chicks Fed Graded Levels of Fat

Supplements to basal ration	Wt. of chicks at 9 wks.		Food Efficiency[1]	Caloric Efficiency[2]
	males	females		
	grams			
New Hampshire chicks				
None	1335	1171	0.38	10.8
2% fat	1322	1115	0.38	10.4
4% fat	1414	1047	0.39	10.4
8% fat	1409	1107	0.39	9.9
White Rock chicks				
None	1269	1114	0.39	11.1
2% fat	1390	1160	0.40	11.0
4% fat	1405	1067	0.40	10.6
8% fat	1374	1172	0.43	10.9

[1]Grams gain per gram food consumed.
[2]Grams gain per 100 crude calories consumed.

These results show that the performance of the birds fed added fat was equal to or slightly superior to the performance when no fat was added. In the second experiment the food efficiency was increased by the addition of fat (see results for 8% fat), and the caloric efficiency data indicate that the calories from the added fat were completely utilized for weight gains, while the experiments with the New Hampshire chicks show a slight reduction in caloric utilization when 8% fat was added.

These results were confirmed in other tests not shown here in which a choline or choline and antibiotic plus B_{12} supplement was also added. In addition, the weights of the male White Rock birds fed 8% added fat were significantly increased over that for the males fed the basal diet. The increased weight gains observed for the males fed the added levels of fat are of extreme interest, and merit additional investigation. Incidentally, the addition of the antibiotic supplement did not increase the weights of the female birds, and the males only to a small extent in the second experiment, with any of the levels of fat fed. Some advantage was observed with the choline plus antibiotic supplements in the earlier phases of the second experiment, but this advantage was essentially eliminated at the time the birds were 9 weeks of age.

STABILITY STUDIES ON INEDIBLE FATS

Extensive studies have been carried out to determine the most effective antioxidants for preventing the development of rancidity in greases and tallows. These studies have been conducted on the effects of antioxidants added to fat on the stability of the fat in accelerated tests and where the stabilized fats have been added to mixed feeds either in accelerated tests or storage tests conducted at room temperature. The main observations pertinent to the present discussion are that: (1) Mixed feeds that contain greases or tallows stabilized with antioxidants do not become rancid after storage at room temperature for at least one year. (2) A mixture of butylated hydroxyanisole (.02%), citric acid (.01%) and propyl gallate (.005%) added to the melted fat was equal or superior to other antioxidant combinations tested. This mixture was employed in stabilizing the fats used in the experiments with dogs and chicks. (3) Hydrogenation of grease added to dry dog food increased the stability of the fat in the mixed feed.

OTHER INFORMATION DEVELOPED IN THESE STUDIES

In addition to the experiments cited here, other experiments to interpret the effect of additions of fat on the performance of dogs and chicks have been conducted. For example, 10 representative birds fed the basal diet and 10 fed the basal diet plus 8% fat were taken to a local poultry processing plant, and the carcass quality (color, finish, etc.), dressing percentages, etc. were evaluated. All birds were judged as excellent, and no significant differences in quality were observed between the two groups.

Studies on the stability of the vitamin A (added as fish liver oil) in the basal ration used in the dog studies and in the rations to which 6% stabilized choice white grease was added are also being conducted. Our initial experiments show that during the first few months' storage of the feeds at room temperature no differences in stability of vitamin A were evident that could be attributed to the addition of stabilized fat. After 6 months' storage, however, a significantly greater stability of vitamin A was evident in the feeds to which the stabilized fat was added. A continued loss of vitamin A occurred in these samples that did not contain 6% of stabilized fat during the 6-10 month storage period.

Improved methods for assessing the rancidity of dry dog foods in accelerated tests have also been developed. The method is based on the premise that substances contributing to the odors noted in organoleptic evaluations of rancidity are carbonyl containing compounds and measurement of these compounds in mixed feeds can be used as an index of rancidity measurement.

DISCUSSION

We conclude that these results show sufficient promise to merit careful consideration by feed manufacturers of the over-all practicality of adding by-product animal fats to dry dog food and to mixed poultry feeds. From the viewpoint of producers of inedible fats the latter represents the larger potential market. In any individual case it would be desirable to conduct larger scale tests in connection with the production of broilers under field conditions. The nutritional quality of the commercial ration used must be considered to ascertain what level of total fat content would be the most desirable (and thereby the level of animal fats to add). Mechanical methods of adding the fat to the feed and the use of suitable bags for the mixed feed – if "oiling out" of the fat with the formulation used occurred – would be factors to consider. The practicability of maintaining a higher fat content of the original feed ingredients should not be overlooked.

We can see no reason why other grades of greases or tallows could not be used as satisfactorily as the choice white grease used in our experiments. In fact, we selected inedible greases rather than tallow to study in order to put the stability of the fats (and of vitamin A) to a more rigid test.

Other advantages not specifically studied that may be evident with the addition of fats are improved palatability of the rations, value of more calories per unit weight of the ration for working dogs and decreased dustiness of the feeds.

A vital factor to consider in the addition of fats to feeds, namely the nutritional quality of the basal ration, cannot be overemphasized. Since fat does not contribute protein, minerals and vitamins, the basal ration must contain sufficient of these nutrients. By the addition of fat, other nutrients are diluted per calorie. Thus, if a ration were borderline in the amount of any nutrient present (for example, protein) addition of fat would reduce the percentage of protein below the optimum level, and the animal's performance would be inferior to that observed when the basal ration was fed.

It should be pointed out that fat was added to the rations in the present study at the expense of the entire ration (i.e., 100 pounds of basal ration plus, for example, 6 pounds of stabilized fat). Therefore, on the basis of the studies outlined here, fat could be successfully added to dry dog meals or poultry rations, providing that fat can compete on a price basis

with the average cost of the entire ration. Furthermore, if fat consistently showed an increased efficiency of food utilization (increased gain for each pound of feed consumed) as observed for the White Rock chicks fed 8% added fat, a considerable additional economic advantage would be realized. Additional costs (mixing, etc.) would have to be considered.

PUBLICATIONS

The detailed results of the studies with dogs will be published in the Journal of Nutrition; those for chicks have been submitted to Poultry Science, and those on the use of antioxidants in mixed feeds have been submitted to Food Technology for publication. These will be available for distribution at a later date.

SUMMARY

These studies show that the growth rate and food utilization of dogs and chicks fed inedible animal fats (choice white grease) in addition to a practical type diet are equal to, or slightly superior to, those observed when the basal ration was fed. The nutritional advantage observed for the male birds with the addition of fat to the diet is of particular importance in the raising of broilers.

Other experiments showed that the animal fats added to the feeds stabilized with antioxidants did not become rancid when stored at room temperature for one year.

No difference in the vitamin A stability was observed during the first few months' storage at room temperature when the stabilized fat was added to rations used in the dog studies. A significantly greater stability of vitamin A occurred after 6 months' storage in the feeds to which stabilized fat was added.

Studies on the reproduction and lactation performance of dogs fed graded levels of stabilized fat and on the effect of stabilized fat on the vitamin A levels in feeds stored at room temperature are being conducted.

The significance of these studies in providing basic information on developing new uses for animal fats is discussed.